

WHAT WE CLAIM IS:

1. A brake apparatus comprising:

a master cylinder having an input shaft which travels according to travel of an operational member for braking maneuver, a master cylinder pressure chamber, and a master cylinder piston which develops master cylinder pressure in said master cylinder pressure chamber according to the travel of said input shaft,

a pump which is driven in braking maneuver,

a braking force control device which controls, in braking maneuver, the discharge pressure of said pump according to at least either the operational condition for service braking or the operational condition for another braking different from the service braking, and

a travel modulating device which modulates the travel of the operational member in braking maneuver by using the discharge pressure of the pump controlled by said braking force control device.

2. A brake apparatus as claimed in claim 1, wherein said travel modulating device controls the travel of said master cylinder piston by using the discharge pressure of the pump controlled by said braking force control device.

3. A brake apparatus as claimed in claim 1 or 2, wherein said pump discharges the discharge pressure by using hydraulic fluid of said master cylinder pressure chamber and the discharge pressure of the pump controlled by said braking force control device is discharged to wheel cylinders as wheel cylinder pressure.

4. A brake apparatus as claimed in any one of claims 1 through 3, wherein said travel modulating device is provided in said master cylinder coaxially with said master cylinder piston.

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5. A breaking apparatus as claimed in any one of claims 2 through 4, wherein said master cylinder piston comprises a first piston which travels when receives the input, and a second piston which is fluid-tightly and slidably disposed relative to said first piston, wherein said second piston is moved relative to said first piston by applying said wheel cylinder pressure to said second piston, thereby controlling the travel of said first piston.

6. A brake apparatus as claimed in claim 5, wherein said second piston is formed in a cylindrical shape having an outer peripheral step, and is fluid-tightly and slidably fitted in an axial bore of a housing of the master cylinder or in a bore of a cylindrical member fixed to said housing, and said first piston is fluid-tightly and slidably fitted in said second piston, said brake apparatus further comprising a control pressure chamber into which said wheel cylinder pressure is introduced and which is formed between the outer periphery of said second piston and the inner periphery of the axial bore of said housing or the inner periphery of a bore of said cylindrical member and is defined by the outer peripheral step of said second piston, wherein said wheel cylinder pressure introduced into said control pressure chamber acts on said outer peripheral step of said second piston, thereby controlling the travel of said first piston.

7. A brake apparatus as claimed in claim 5, wherein said second piston is formed in a cylindrical shape having an inner peripheral step, and

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said first piston is fluid-tightly and slidably fitted in an axial bore of said second piston, said brake apparatus further comprising a control pressure chamber into which said wheel cylinder pressure is introduced and which is formed between the inner periphery of said second piston and the outer periphery of said first piston and is defined by the inner peripheral step of said second piston, wherein said wheel cylinder pressure introduced into said control pressure chamber acts on said inner peripheral step of said second piston, thereby controlling the travel of said first piston.

8. A brake apparatus as claimed in claim 4, wherein said input shaft, which is moved by the input according to the travel of the operational member, is movable relative to said master cylinder piston, said brake apparatus further comprising a control spring which is disposed in a compressed state between said input shaft and said master cylinder piston for controlling the travel of said input shaft, wherein said input of said input shaft and the spring force of said control spring act in the same direction, said wheel cylinder pressure acts on said input shaft against said input and the spring force of said control spring, and said wheel cylinder pressure is controlled such that the force produced by said wheel cylinder pressure, said input, and the spring force of said control spring are balanced.

9. A brake apparatus as claimed in any one of claims 1 through 3, wherein said travel modulating device is located out of the central axis of said master cylinder piston.

10. A brake apparatus as claimed in claim 9, wherein said

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operational travel modulating device has a travel modulating piston for controlling the travel of said master cylinder piston, said travel modulating piston is moved by applying said master cylinder pressure to said travel modulating piston in one direction and applying said wheel cylinder pressure to said travel modulating piston in a direction opposite to said one direction, thereby controlling the travel of said master cylinder piston.

11. A brake apparatus as claimed in claim 10, wherein said travel modulating piston is composed of a large-diameter piston portion at its one side portion and a small-diameter piston portion at its the other side portion, said master cylinder pressure acts on said large-diameter piston portion and said wheel cylinder pressure acts on said small-diameter piston portion.

12. A brake apparatus as claimed in claim 10, wherein said travel modulating piston is composed of a large-diameter piston portion at its one side portion and a small-diameter piston portion at its the other side portion, said master cylinder pressure acts on said large-diameter piston portion and said wheel cylinder pressure acts on a step between said large-diameter piston portion and said small-diameter piston portion.

13. A brake apparatus as claimed in any one of claims 10 through 12, further comprising a biasing means for biasing said travel modulating piston in a direction opposite to the action of said master cylinder pressure, wherein said wheel cylinder pressure is controlled such that the force produced by said master cylinder pressure, the force produced by said wheel cylinder pressure, and the biasing force of said biasing means are

balanced.

14. A brake apparatus as claimed in any one of claims 11 through 13, wherein said large-diameter piston portion is sealed by metal seal and said small-diameter piston portion is sealed by at least either metal seal or elastic seal.

15. A brake apparatus as claimed in any one of claims 1 through 14, wherein in the event of failure of said pump, said master cylinder pressure is supplied to said wheel cylinders.

16. A brake apparatus as claimed in any one of claims 1 through 15, wherein the input is applied to said master cylinder piston after intensified by a brake pressure intensifying device at a preset servo ratio by using pressure of a pressure source, and said servo ratio is set smaller than the servo ratio normally used for service braking. *conventional*

17. A brake apparatus as claimed in claim 16, wherein in the event of failure of said pressure source, the force applied to said operational member is transmitted through said brake pressure intensifying device without magnification.

18. A brake apparatus as claimed in claim 1, wherein said travel modulating device controls the travel of said input shaft according to the discharge pressure of the pump controlled by said braking force control device.

19. A brake apparatus as claimed in claim 18, wherein said travel modulating device has a travel control spring disposed between said master cylinder piston and said input shaft, and said travel modulating device

shortens the travel of said input shaft such that the discharge pressure of the pump controlled by a pressure control valve, the spring force of said travel control spring, and said input are balanced.

20. A brake apparatus as claimed in claim 18 or 19, wherein said braking force control device controls such that the discharge pressure of said pump is greater when another braking different from said service braking is not conducted, and the discharge pressure of said pump is smaller when said another braking is conducted.

21. A brake apparatus as claimed in any one of claims 18 through 20, wherein said master cylinder piston is operated with the discharge pressure of said pump controlled by said braking force control device, and wheel brakes are actuated with master cylinder pressure developed by this operation of said master cylinder piston.

22. A brake apparatus as claimed in any one of claims 18 through 20, wherein wheel brakes are actuated with the discharge pressure of the pump controlled by said braking force control device.

23. A brake apparatus as claimed in any one of claims 1 through 22, wherein said another braking is a regenerative braking.